

Tilburg University

Vacancy durations

van Ours, J.C.; Ridder, G.

Published in:
Oxford Bulletin of Economics and Statistics

Publication date:
1993

[Link to publication in Tilburg University Research Portal](#)

Citation for published version (APA):
van Ours, J. C., & Ridder, G. (1993). Vacancy durations: Search or selection? *Oxford Bulletin of Economics and Statistics*, 55(2), 187-198.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal

Take down policy

If you believe that this document breaches copyright please contact us providing details, and we will remove access to the work immediately and investigate your claim.

VACANCY DURATIONS: SEARCH OR SELECTION?

*J. C. van Ours and G. Ridder**

I. INTRODUCTION

There is a renewed interest in the use of vacancy data in empirical macroeconomics. Following the lead of Diamond (1971), economists consider the matching of jobs and workers in the labour market as a productive activity, that can be described by a production function, the matching function. In the matching function the number of new hires is related to the number of workers (employed or unemployed) who are looking for a job and the number of jobs who are looking for a worker, i.e. the number of job vacancies.¹ If the matching function has constant returns to scale, as is confirmed in most empirical studies, then the matching function implies a stable relationship between the average duration of unemployment and the average duration of vacancies.

As stressed by Blanchard and Diamond (1989) and Jackman, Layard and Pissarides (1989), decomposing changes of these durations in movements along and shifts of this relation is helpful in understanding the causes of cyclical and secular changes in the unemployment rate. For instance, Jackman, Layard and Pissarides find that between 1960 and 1982 the unemployment/vacancy duration curve has shifted outward in the UK, and by a process of elimination they conclude, that the cause of this shift is that the unemployed have decreased their intensity of search.

Although the measurement of unemployment has its own ambiguities, it is clear that the concept of a job vacancy is the more elusive of the two. In a steady state the number of job vacancies is equal to the product of the rate at which vacancies are created and the average duration of the vacancies. It is usually assumed, that the number of vacancies at a firm is equal to the difference between the number of productive jobs and the present number of employees, so that the rate at which vacancies are created is equal to the sum of the net rate at which productive jobs are generated and the rate at which

*The authors would like to thank the Organization for strategic Labor Market Research (OSA) for the use of the vacancy data and Ruud Koning and Ken Burdett for helpful comments.

¹ Although the matching function approach goes back to at least Holt (1970), more recent contributions are Jackman, Layard and Pissarides (1989) and Blanchard and Diamond (1989).

employees quit. The determination of the duration of the vacancy depends on the search strategy of the employers. In van Ours and Ridder (1992) we show that employers use a non-sequential search strategy: applicants arrive shortly after the vacancy has been posted, and the rest of the vacancy duration is used to select a new employee from the pool of applicants. Hence, a vacancy duration consists of an application period, during which applicants arrive, and a selection period, during which a new employee is chosen from the pool of applicants. In this paper we propose a simple method to estimate the length of both periods using data on applicant arrivals. We find, that employers spend far more time on selecting than on attracting applicants.

The distinction between application and selection is important for an unambiguous interpretation of shifts of the unemployment/vacancy duration curve. If vacancy durations are mainly selection periods, then an increase in the vacancy duration for a given duration of unemployment does not necessarily imply that the search effort of the unemployed has decreased. It only indicates, that employers spend more time on, and presumably put more effort in, the selection of a new employee from a pool of applicants, that is formed in the same short interval as before.

Because our data pertain to a particular year, 1987, we do not know how application and selection periods vary over the cycle. This is a major weakness of our results. Our contribution is a simple method to estimate both components of the vacancy duration. If in the vacancy surveys, that in the Netherlands are conducted yearly, a question on the number of applicants for a vacancy would be included, our method could be used to obtain yearly estimates of both components.

II. SOME THEORETICAL CONSIDERATIONS

Van Ours and Ridder (1992) find that in their sample of job vacancies the applicant arrival rate is high during the first few weeks after a vacancy has been posted and is small during the rest of the duration of the vacancy, while the rate at which vacancies are filled is almost zero during the first month and increases during the next four months. This indicates that employers use a non-sequential search strategy when filling job vacancies. Most new employees are hired from a pool of applicants that is formed shortly after the vacancy is opened.² Moreover, it takes some time before a suitable new employee is selected from the pool of applicants.

This result comes as no surprise, because it is well known (Gal, Landsberger and Levykson, 1981; Morgan, 1983), that a compound strategy in which the searcher can generate more than one offer at some cost dominates a sequential search strategy. Moreover, employers put effort into

² This is also consistent with the observation that 69 percent of the vacancies are advertised with 80 percent of these being advertised only once.

the assessment of the suitability of applicants (Barron and Bishop, 1985; Barron, Bishop and Dunkelberg, 1985), and this assessment takes time. Hence, the empirical finding that a vacancy duration can be divided in an application period and a selection period makes sense from a search theoretical perspective.

What determines the length of the application and selection periods? First, we shall present a very stylized model for the determination of the application period, that we denote by T . The selection period has length S . During the application period applicants arrive at a rate μ . An applicant is characterized by the revenue product x , which is a draw from a distribution with distribution function F . At the end of the application period there is a pool of $N(T)$ applicants. In the selection period the revenue product of the applicants is assessed, and at the end of the selection period the applicant with the largest revenue product is selected from the pool of applicants. The remaining pool of applicants at time $T + S$ is smaller than $N(T)$ due to attrition from the pool at rate δ . In the sequel we ignore random variation around the mean in the size of the pool at $T + S$, i.e. the size of the pool at $T + S$ is $\mu T - \delta S$.

Employers set the wage w before the start of the application period on the basis of the expected productivity of the new employee. Morale problems with incumbent employees will restrict the employer's possibilities to bargain over the wage, and we shall assume that such bargaining does not occur.

For given S the employer maximizes the following expected discounted (at rate r) profit

$$E(P(T, S)) = \frac{e^{-r(T+S)}}{r} \left(\int_0^\infty (1 - F(x)^{\mu T - \delta S}) dx - w \right) = \frac{e^{-r(T+S)}}{r} p(T, S) \quad (1)$$

If $p(T, S)$ denotes the instantaneous expected profit flow, then the first order condition is

$$r = \frac{\partial \log(p(T, S))}{\partial T} \quad (2)$$

Hence T equates the discount rate to the relative change in the profit rate associated with a one time unit increase in T .³

The solution to (2) satisfies

$$\partial \mu T / \partial \mu > 0 \quad (3a)$$

$$\partial \log T / \partial \log \delta = \partial \log T / \partial \log S = \delta S / \mu T > 0 \quad (3b)$$

$$\partial T / \partial w > 0 \quad (3c)$$

$$\partial T / \partial r < 0 \quad (3d)$$

³ It is not difficult to show that (2) has a unique positive solution.

From (3a) it follows that the size of the pool of applicants increases with the arrival rate of applicants. The sign of the derivative of the application period with respect to the arrival rate is ambiguous,⁴ but likely to be negative. From (3b) we conclude that the elasticities of T with respect to the attrition rate and the selection period are predicted to be identical and equal to the relative size of the attrition and the initial pool of applicants. In particular, $\partial T/\partial S = 0$ if $\delta = 0$. Hence, if there is no attrition the application and selection periods are independent. In a tight labour market μ will be small and δ large. In that case we expect a relatively long application period, and the reverse holds in an easy labour market. Hence, we predict procyclical variations in T . From (3c) we obtain that jobs that command a high wage, have a relatively long application period.

If we take the size of the pool of applicants μT as a measure of extensive search, then the inequalities (3a) and (3c) are in line with the results of Barron and Bishop (1985) and Barron, Bishop and Dunkelberg (1985), who find that there is more extensive search for vacancies that have a large arrival rate of applicants, and that there is a positive correlation between the starting wage and extensive search.

Until now we have treated the selection period S as given. Building a model for S requires knowledge of the selection technology used by employers. The length of the selection period is determined by the selection capacity of the firm and the intensity of the selection. The intensity of selection, measured by the number of hours spent on selection per applicant, has been studied by Barron *et al.*, who find that restrictions on firing employees and the training involved in the job have a large positive effect on the intensity of the selection procedure. In general, we expect that selection is more intensive if the contract is more risky from the point of view of the employer. In our empirical model we shall include variables to test this hypothesis.

III. DATA AND ESTIMATION RESULTS

3.1. Data

The data are taken from the Organization of Strategic Labor Market Research (OSA) vacancy survey. This survey was conducted in two stages. In the first stage with interviews in November–January 1986–87, a sample of employers gave information on the incomplete duration of their vacancies and the cumulative number of applicants at the date of the first interview of the survey. Furthermore, some characteristics of the employer and the vacancies were recorded. Unfortunately, neither characteristics of the applicants, nor wage offers (if any) made to applicants were collected. In the sec-

⁴ If $Tr > 1$ or if firms make zero profit on the marginal employee, then the application period decreases with the arrival rate of applicants.

TABLE 1
Sample Means

	<i>Filled at 2nd interview</i>	<i>Open at 2nd interview</i>	<i>All vacancies</i>
<i>Job requirements</i>			
Required education (level) ¹	2.98	3.29	3.06
Required experience (years)	1.21	1.73	1.35
<i>Type of job</i>			
Commercial ²	0.48	0.27	0.42
Industry ³	0.23	0.31	0.26
<i>Recruitment channels</i>			
Advertisement	0.59	0.58	0.59
Labour exchange	0.31	0.34	0.31
<i>Firm characteristics</i>			
Number of employees (× 1000)	0.39	0.50	0.44
Psychological test	0.25	0.39	0.29
Elapsed duration (months)	1.82	2.53	2.01
Cumulative number of applicants at date first interview	12.1	8.0	11.1
<i>N</i>	496	174	670

¹ The levels are:

1 = primary

2 = extended primary

3 = secondary

4 = higher vocational

5 = university

² Service, clerical or commercial job
CBS job classification codes: 3, 4, 5.³ Industry job
CBS job classification codes: 6, 7.

ond stage of the survey, conducted some four months later, employers were asked for the date at which the vacancies of the first interview were filled (if they were filled). In this paper we use a subsample of 670 vacancies, of which 496 (74 percent) were filled at the date of the second interview.⁵ The data are summarized in Table 1.

Most variables need no discussion. The advertisement dummy refers to the placement of a personnel advertisement (1=yes), and the labour exchange dummy is 1 if the labour exchange has been notified. If the selection procedure involves a psychological test then the corresponding dummy is 1.

⁵ A more detailed description of the survey and the selection that is used in the present paper can be found in van Ours and Ridder (1992).

The definition of vacancy duration needs some discussion. In the OSA survey the employer is asked: 'Do you have at this moment job vacancies for which you are searching employees whom you want to put to work immediately or as soon as possible?'. So, employers may start searching for a new employee before the present employee has left.⁶ The beginning of a vacancy is defined as the date the search process started and not as the date the job became unoccupied. Vacancies may be considered as filled on the moment an employer hires a new employee or the (usually later) moment a new employee starts on the job. We use information on the hiring moment to calculate the vacancy duration. Therefore our vacancy durations refer to periods of search and not to periods during which jobs are unoccupied.

The information on applicants refers to the cumulative number at the date of the first interview and excludes possible attrition, of which we have no information.

3.2. *An Empirical Model*

To obtain estimates of the average application and selection periods we propose a simple statistical model that uses information on the length of the vacancy and the arrival of applicants. To be specific, we assume that T and S are exponentially distributed with parameters θ and λ . Applicants arrive according to a Poisson process with intensity μ . We relate the intensities to a vector of explanatory variables X

$$\mu = \exp(\beta'_A X), \quad \theta = \exp(\beta'_T X), \quad \lambda = \exp(\beta'_S X) \quad (4)$$

We assume that there is no hiring during the application period, and we assume that no applicants arrive during the selection period. These assumptions are in line with the evidence in van Ours and Ridder (1992) and are graphically illustrated in Figure 1. Both assumptions define the application and selection period and enable us to identify them.

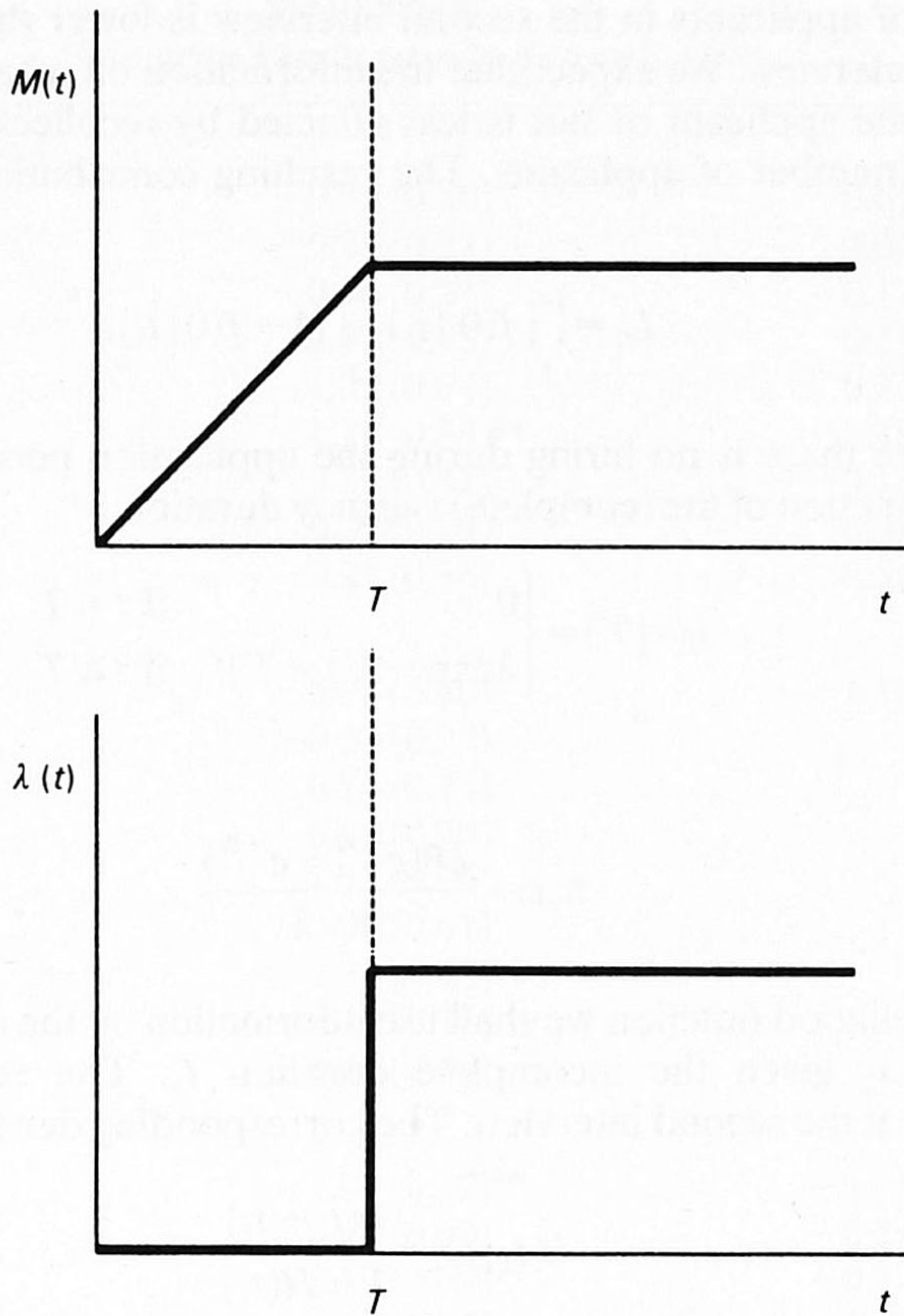
Let t_1 denote the incomplete vacancy duration at the date of the (first) interview. The number of applicants at t_1 has density (with respect to the counting measure)

$$f(k | t_1, T) = \begin{cases} (\mu t_1)^k \exp(-\mu t_1)/k! & \text{if } t_1 < T \\ (\mu T)^k \exp(-\mu T)/k! & \text{if } t_1 \geq T \end{cases} \quad (5)$$

Integrating out T we obtain

$$f(k | t_1) = \int_0^{t_1} ((\mu T)^k e^{-\mu T}/k!) \theta e^{-\theta T} dT + (\mu t_1)^k e^{-\mu t_1}/k! e^{-\theta t_1} \quad (6)$$

⁶ In January 1988, 32 percent of all vacancies in the Netherlands referred to occupied jobs.



$M(t)$ = number of applicants at t
 $\lambda(t)$ = vacancy hazard rate at t
 T = application period
 t = duration of vacancy

Fig. 1. Applicants and vacancy hazard rate over the duration of the vacancy

and the probability that no applicant has arrived by t_1 is

$$f(0 | t_1) = \frac{\theta + \mu e^{-(\mu + \theta)t_1}}{\mu + \theta} \quad (7)$$

In the likelihood function we only use the information that either no person (group 1) or at least one person (group 2) has applied at the date of the first interview. In this way we minimize the impact of measurement and recollection errors. Inspection of the data reveals that there is considerable rounding of the number of applicants, and that for a number of vacancies the reported

number of applicants in the second interview is lower than that reported in the first interview. We expect that the information on whether there has been at least one applicant or not is less affected by recollection errors than the reported number of applicants. The resulting contribution to the likelihood function is

$$L_1 = \prod_1 f(0 | t_1) \prod_2 (1 - f(0 | t_1)) \quad (8)$$

Because there is no hiring during the application period, we find for the density function of the (complete) vacancy duration

$$h(t | T) = \begin{cases} 0 & \text{if } t < T \\ \lambda \exp - \lambda(t - T) & \text{if } t \geq T \end{cases} \quad (9)$$

Hence

$$h(t) = \frac{\lambda \theta (e^{-\lambda t} - e^{-\theta t})}{\theta - \lambda} \quad (10)$$

In the likelihood function we shall use information on the conditional residual duration t_2 given the incomplete duration t_1 . The residual duration is observed at the second interview. The corresponding density is

$$h(t_2 | t_1) = \frac{h(t_1 + t_2)}{1 - H(t_1)} \quad (11)$$

with H the distribution function of the complete vacancy duration.

At the date of the second interview some vacancies have been filled at a known date (group 1), some will still be open (group 2), and some have been filled at some unknown date between the first and second interview (group 3). Hence, the (conditional on t_1) likelihood function is

$$L_2 = \prod_1 h(t_2 | t_1) \prod_2 \int_{t_2}^{\infty} h(s | t) ds \prod_3 \int_0^{t_2} h(s | t_1) ds \quad (12)$$

Note that to minimize recollection errors we do not use the information on the incomplete vacancy duration at the date of the first interview. The complete likelihood function is the product of L_1 in (8) and L_2 in (12).

3.3. Estimation Results

By maximizing the likelihood functions, i.e. the product of L_1 and L_2 , we obtain Maximum Likelihood estimates of the parameters of the model. These ML estimates are reported in Table 2.

TABLE 2
Estimation Results (standard errors)

<i>Applicant arrival rate (μ)</i>		
Constant	-0.35 (0.70)	-0.63 (0.44)
Required education	-0.27 (0.21)	0.00 (0.13)
Required experience	0.06 (0.21)	-0.12 (0.09)
Commercial	0.72 (0.55)	0.29 (0.22)
Industry	1.22 (0.84)	0.22 (0.27)
Advertisement	1.19 (0.54)**	1.18 (0.19)**
Labour exchange	0.32 (0.41)	0.18 (0.20)
No. of employees	0.21 (0.23)	0.34 (0.17)**
Psychological test	-0.21 (0.36)	0.15 (0.23)
<i>Application period (θ)</i>		
Constant	-0.93 (0.80)	-1.13 (0.11)**
Required education	-0.33 (0.23)	
Required experience	0.24 (0.24)	
Commercial	0.63 (0.70)	
Industry	1.27 (0.96)	
Advertisement	0.06 (0.61)	
Labour exchange	0.20 (0.42)	
No. of employees	-0.19 (0.21)	
Psychological test	-0.42 (0.40)	
<i>Selection period (λ)</i>		
Constant	-1.94 (0.32)**	-1.98 (0.19)**
Required education	-0.11 (0.09)	-0.19 (0.05)**
Required experience	-0.19 (0.09)**	-0.14 (0.04)**
Commercial	0.21 (0.25)	0.38 (0.11)**
Industry	-0.39 (0.22)*	-0.20 (0.14)
Advertisement	0.11 (0.17)	0.12 (0.09)
Labour exchange	-0.10 (0.14)	-0.06 (0.10)
No. of employees	0.01 (0.10)	-0.07 (0.07)
Psychological test	-0.14 (0.17)	-0.20 (0.11)*
-log L	1951.3	1957.7
-log L_1	319.2	324.9
-log L_2	1626.3	1632.7

** Significant at 5% level.

* Significant at 10% level.

Given the limited amount of information that we use, it is not surprising that many parameters are poorly determined. More reliable data on the number of applicants can improve this substantially. In particular, the regression parameters that refer to the application period have large variances: the included explanatory variables seem to have no impact on the mean application period. For that reason we estimated a restricted version of the model in

which the mean application period is constant. The results are reported in the second column of Table 2.

If we concentrate on the parameters that are significantly different from zero, then we conclude that the mean selection period increases with the required level of education and experience. Given the restrictions on the firing of employees in the Netherlands, it is likely that employers perceive contracts with higher skilled workers as relatively risky. Note that required education and experience have no effect on the applicant arrival rate. It comes as no surprise, that the application arrival rate is much larger for vacancies that have been advertised. Notification of the labour exchange does not lead to a larger flow of applicants. Larger firms also attract more applicants, but the monitoring problem that one expects in large firms, does not lead to a longer selection period. Selection procedures that involve a psychological test take more time than procedures without such a test. Selection periods for commercial jobs are relatively short.

From L_1 in (8) we can estimate β_A and β_T , and from L_2 in (12) β_T and β_S . Hence, as a simple specification test we can check whether the estimates of β_T agree. For both sets of estimates in Table 2 we cannot reject equality [LR-statistics 11.6 (9 d.f.) and 0.2 (1 d.f.)]. Moreover, it is easily verified, that the simplification in column 2 is allowed [LR-statistic 12.8 (8 d.f.)]. Finally, we introduced unobserved heterogeneity in the constant of λ (two mass-points with locations estimated jointly with the corresponding probabilities). This did not improve the fit of the model significantly ($-\log L$ is 1956.8).

Using the estimates in the second column of Table 2 we compute mean selection and application periods and the expected number of applicants. The explanatory variables are set at their mean values reported in the last column of Table 1. The results are

Mean application period:	3.1 weeks
Mean selection period:	14.6 weeks
Required education primary level	9.9 weeks
Required education university	21.1 weeks
No experience required	12.1 weeks
Expected cumulative number of applicants during application period:	4.3

We conclude from these computations that vacancy durations are mainly selection periods. This is in line with the results reported in van Ours and Ridder (1992). In comparing the expected number of applicants reported here with the number in Table 1, one has to bear in mind that the latter number is most likely affected by recollection errors. Our confidence in the results is boosted by the sensible patterns that emerge by looking at different types of vacancies.

The estimated mean selection period is rather long. This may be due to a misinterpretation with respect to the date a vacancy was filled. This date should refer to the hiring of a new employee but may have been interpreted by some employers as the date a new employee started on the job. Nevertheless, the patterns in the mean selection periods appear to be quite plausible.

The estimated mean application period is short. This is not surprising. In 1986-87 about 1 percent of the employers in manufacturing reported production problems because of difficulties in hiring employees. In the 1970's this number fluctuated around 12 percent.⁷ Hence, in the period of the survey very few employers had difficulties in attracting applicants, and this is reflected in a short mean application period.

IV. CONCLUSION

In this paper we have proposed a simple method for the decomposition of (average) vacancy durations in application and selection periods. Our estimates confirm our earlier result that vacancy durations are mainly selection periods, and that attracting a pool of applicants takes relatively little time. Our results imply that the shift in the unemployment/vacancy duration curve, that has been observed by a number of authors may be due to longer selection periods, i.e. by increased choosiness on the side of the employers, and not to a lower search intensity of the unemployed. For more definitive conclusions we would like to repeat the analysis at various stages of the business cycle.

Department of Economics, Vrije Universiteit, Amsterdam.

Date of Receipt of Final Manuscript: July 1992

REFERENCES

- Barron, J. M. and Bishop, J. (1985). 'Extensive search, intensive search, and hiring costs', *Economic Inquiry*, Vol. 23, pp. 363-82.
- Barron, J. M., Bishop, J. and Dunkelberg, W. C. (1985). 'Employer search', *Review of Economics and Statistics*, Vol. 67, pp. 43-52.
- Blanchard, O. J. and Diamond, P. (1989). 'The Beveridge curve', *Brookings Papers on Economic Activity*, 1, pp. 1-76.
- Diamond, P. (1971). 'A model of price adjustment', *Journal of Economic Theory*, Vol. 3, pp. 156-78.
- Gal, S., Landsberger, M. and Levykson, B. (1981). 'A compound strategy for search in the labor market', *International Economic Review*, Vol. 22, pp. 597-608.

⁷ These numbers are taken from the CBS Business Cycle Test (various years).

- Holt, C. C. (1970). 'How can the Phillips curve be moved to reduce both inflation and unemployment', in Phelps, E. S. *et al.* (eds), *Microeconomic Foundations of Employment and Inflation Theory*, Norton, New York
- Jackman, R., Layard, R. and Pissarides, C. (1989). 'On vacancies', *BULLETIN*, Vol. 51, pp. 377-94.
- Morgan, P. B. (1983). 'Search and optimal sample sizes', *Review of Economic Studies*, Vol. L, pp. 659-75.
- Ours, J. C. van and Ridder, G. (1992). 'Vacancies and the recruitment of new employees', *Journal of Labor Economics*, Vol. 10, pp. 138-55.